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ON THE THERMAL RADIATION OF JUPITER

by

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SUMMARY

On the basis of spectroscopic data it is assumed that the atmosphere of Jupiter consists of H_2, CH_4 and NH_3 (the reduced heights are 5500 m, 150 m and 7 m). The optical thickness of the isothermic atmosphere (130° K) in the wavelength range $\lambda \simeq 1.3\,\text{mm} \div 3\,\text{cm}$ is computed and the levels of radiation yield are determined. The brightness temperature of the planet, T_B in the region $\lambda \simeq 5\,\text{mm} \div 3\,\text{cm}$ is computed for different gradients κ and heights h_c of the troposphere in the case of non-isothermic atmosphere models. The difference between T_B and the infrared temperature of the cloud layer at $h_c = 36.9$ km and $\kappa = -2.01°$ K/km reaches $\simeq 70°$ K in the region $\lambda \simeq 1.25$ cm. It is noted that the wavelength range $\lambda \simeq 1.05\,\text{cm} \div 1.54$ cm is the most suitable for an experimental verification of the computations.

* * *

Two forms of Jupiter's radioemission are currently observed: the sporadic, in the wavelength region $\lambda = 10\,\text{m} \div 60\,\text{m}$, and the continuous in the $\lambda = 3\,\text{cm} \div 70\,\text{cm}$ wave band. The brightness temperature T_B of the planet rises from $140 \div 170°$ K at $\lambda \simeq 3$ cm [1 — 4] to several tens of thousand degrees at $\lambda \simeq 70$ cm [5 — 7]. An attempt to explain such high brightness temperatures by thermal radiation of the atmosphere with an adiabatic temperature gradient, was found to be unsuccessful in spite of

* O TEPLOVOM IZLUCHENII YUPITERA

the clearly overrated atmosphere transparency adopted in the computations of the work [8]. One may point to still other properties of continuous radiation, as evidence of its nonthermal character (the angular diameter exceeds the optical one by a factor of ~ 3 [9], the radiation intensity in the $\lambda \simeq 10$ cm $\div$ 20 cm band varies with time, etc. [10 – 12]). The most probable source of continous radiation is generally considered to be in the emission of electrons from radiation belts (see, for example, [8, 13]). As to the spectral region $\lambda \lesssim 3$ cm, it may be assumed that the character of radiation there is thermal, for the brightness temperature of 140° K differs little from the infrared temperature, equal to 130° K [14 – 16].

We shall consider in the following the thermal radiation of Jupiter in the wavelength region $\lambda \simeq 1.3$ mm $\div$ 3 cm. The indicated region is interesting in that resonance frequencies of ammonia inversion spectrum are present there, and, according to the available data (discussed at further length in the paragraph 1 below) ammonia enters into the composition of the atmosphere in that region. Comparison of the measured brightness temperature with the computed for specific models of planet's atmosphere provides the possibility of obtaining a certain information on the physical conditions of the planet. Although presently experimental data on Jupiter's radiation exist mainly in wavelengths $\lambda > 3$ cm*, the rapid strides in the measurement techniques allow us to hope to obtain shortly information in wavelengths < 3 cm too. Possible variants in the determination of the properties of the atmosphere according to observations in ultrahigh frequencies with the aid of rockets, are, in particular, discussed in the work [18].

1.- MODEL OF JUPITER'S ATMOSPHERE. The measured infrared temperature of Jupiter is usually referred to the layer of clouds that conceals the planet's surface and the lower part of the atmosphere (130° K). We admitted that clouds emit as an absolute blackbody with temperature of 130° K (T_0). Above clouds absorption bands of NH_3, CH_4 and H_2 are observed and their reduced heights are respectively 7 m, 150 m and 5 500 m [14, 19]. Although the temperature of 130° K is below ammonia's freezing point,

* A value $T_B < 200^\circ$ K was obtained at $\lambda \simeq 0.86$ cm in [17].

spectroscopic investigations attest to the presence of gaseous ammonia in the atmosphere of Jupiter. From general considerations one might also expect the presence in it of helium, neon, nitrogen and argon; however, no experimental corroboration of the presence of these gases in the atmosphere of Jupiter are available as yet *. We assumed that the above-cloud part of the atmosphere consists only of NH_3, CH_4 and H_2 in amounts shown above, which corresponds to the following percent content by the number of particles : 97.22 % H_2 , 2.66 % CH_4 and 0.12% NH_3. Assuming also that the chemical composition of the atmosphere does not vary with height, the mean molecular weight **m** of the gas was then obtained equal to $3.95 \cdot 10^{-24}$ g Considered below are several model atmospheres :

a) isothermic atmosphere with temperature T_0.

b) two-layer models, consisting of nonisothermic troposphere with various temperature gradients and heights, and isothermic stratosphere.

In the case of isothermic atmosphere (case **a**) the pressure P varies with height h_i according to the law

$$P = P_0 e^{-h_i/H_0} \tag{1}$$

The pressure at cloud surface is $P_0 = 1{,}476 \cdot 10^5$ inch/cm^2 and the scale of heights is $H_0 = (kT_0 / mg) = 18.45$ km (g is the free fall acceleration, **k** is the Boltzmann constant).

In the case b):

$$\left.\begin{aligned} T &= T_0 + \varkappa h_i \\ P &= P_0\left(1 + \frac{\varkappa h_i}{T_0}\right)^{-mg/k\varkappa} \end{aligned}\right\} 0 \leqslant h_i < h_c, \tag{2}$$

where h_i is counted from the cloud level, h_c is the height of the troposphere, $\varkappa$ is the temperature gradient.

$$\left.\begin{aligned} T &= T_c \\ P &= P_c e^{-(h_i-h_c)/H_c} \end{aligned}\right\} h_i \geqslant h_c,$$

where

$$T_c = T_0 + \varkappa h_c, \quad P_c = P_0 (T_c/T_0)^{-mg/k\varkappa} \tag{3}$$

and

$$H_c = \frac{kT_c}{mg}.$$

Information on the dependence T (h_i) in Jupiter's atmosphere is absent, and that is why we completed the computations of brightness temperature

* That is why we consider other models than that taken in [20]. Spectroscopic investigations do not confirm the amount of H_2 taken in [14].

for three different gradients $\varkappa = \pm 1\,^\circ\mathrm{K}/\kappa\mathit{m}, -2.01\,^\circ\mathrm{K}/\kappa\mathit{m}$* (the latter value is equal to the adiabatic gradient). We assumed for the same reason the quantity h_c to be equal to $\frac{1}{2}H_0, H_0, \frac{3}{2}H_0, 2H_0$. for each gradient.

2.- Calculation Formulas.- The optical thickness of the atmosphere layer lying above the level h_i is:

$$\tau(\nu, h_i) = \int_{h_i}^{\infty} \alpha(\nu, h_i)\, dh_i, \qquad (4)$$

where $\alpha(\nu, h_i)$ is the absorption coefficient at level h_i in the atmosphere and at frequency ν_i. The brightness temperature of the planet at the frequency ν is:

$$T_B(\nu) = 2\left\{ T_0 \int_0^1 e^{-\tau_m/\mu} \mu\, d\mu + \int_0^1 \int_0^{\tau_m} T(\tau) e^{-\tau/\mu} d\tau\, d\mu \right\}, \qquad (5)$$

where τ_m is the optical thickness of the above-cloud layer, $\mu = \cos\,\theta$, where θ is the spherical coordinate of the point at planet's surface. If we assume that the brightness of the visible disk of the planet is identical everywhere and is equal to the brightness at disk's center, formula (5) may be written in the form**:

$$T_B(\nu) = T_0 e^{-\tau_m} + \int_0^{\tau_m} T(\tau) e^{-\tau}\, d\tau. \qquad (6)$$

For a two-layer atmosphere we shall have :

$$T_B(\nu)\, T_0 e^{-\tau_m} + T_c(1 - e^{-\tau_c}) + \int_{\tau_c}^{\tau_m} T(\tau) e^{-\tau} d\tau, \qquad (7)$$

where τ_c is the optical thickness of the stratosphere at the frequency ν.

The absorption coefficient of the atmosphere may be represented in the form of the sum of the coefficients of separate absorbing components :

$$\alpha(\nu, h_i) = \alpha_{NH_3} + \alpha_{CH_4} + \alpha_{H_2}. \qquad (8)$$

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* Although the darkening of Jupiter's disk at the edges, obtained in [16] in wavelengths $\lambda = 8 \div 14\mu$ speaks in favor of negative gradient of planet's nonisothermic atmosphere.

** The estimates of the error then admitted, are brought out in para. 3.

The molecules H_2 and CH_4 do not have a constant dipole moment and they induce in the microwave band a very low absorption, conditioned only by the induced dipole moment (at collisions). Estimates of energy absorption by the gas, consisting of linear molecules and endowed with quadrupole moment were completed in [21]. Analogous estimates for hydrogen in Jupiter's atmosphere lead to the ratio $\alpha_{H_2}/\alpha_{NH_3} < 10^{-3}$ at $\lambda \gtrsim 0.6$ *см*. The intermolecular interaction of molecules CH_4 is determined by short-range forces (London dispersion, exchange forces). The last circumstance, and also the low content in methane (by comparison with hydrogen) in the atmosphere of Jupiter give the correlation $\alpha_{CH_4} \ll \alpha_{H_2}$. Therefore, the nontransparency of the atmosphere of Jupiter in wavelengths $\lambda \approx 5$ mm $\div$ 3 cm in the models admitted is determined by the absorption of ammonia only; its inversion spectrum corresponds to the region $\lambda \approx 1.25$ cm, and the presence of hydrogen and methane molecules is manifest in the half-widths of spectral lines of NH_3 (for details, see below).

The absorption coefficient of ammonia may, according to [22), be written in the form:

$$\alpha_{NH_3} = \frac{32\pi^2\nu^2}{3hc}\Sigma_{ij}(N_i - N_j)(\mu_{ij})^2 \frac{\nu_{ij}\Delta\nu_{ij}}{(\nu_{ij}^2 - \nu^2)^2 + 4\nu^2(\Delta\nu_{ij})^2}. \qquad (9)$$

In the formula (9) the structural factor is written in the form obtained from the solution of the kinetic equation [23]. $N_i - N_j$ is the difference in the populations between the i and j- levels, μ_{ij} is the matrix element of the dipole moment for the transition $i \rightarrow j$, ν_{ij} is the resonance frequency, ν is the frequency of the external electromagnetic field, $\Delta\nu_{ij}$ is the half-width of the spectral line, h and c are respectively the Planck constant and the speed of light. The summing up in the expression (9) is effected by all inversional transitions, whose resonance frequencies amd half-widths depend on the rotational state of the molecule.

Since the rotational frequencies of NH_3 exceed significantly the corresponding inversional frequencies of the ground state, we have

$$N_i - N_j = N_{JK}\frac{1 - e^{-h\nu_{ij}/kT}}{1 + e^{-h\nu_{ij}/kT}}$$

where N_{JK} is the population of the rotational state with quantum numbers

J and K (the NH_3 molecule is a symmetrical rotator). If we utilize for H_{JK} the expression (3.48) from [24], and the indices i and j in resonance frequencies, matrix elements and half-widths are substituted by the corresponding values of J and K, we shall obtain instead of (9):

$$\alpha_{NH_3} = \frac{16\pi^2 N\nu^2}{ckT}\sqrt{\frac{B^2Ah^3}{\pi(kT)^3}}\sum_{JK}|\mu_{JK}|^2\nu_{JK}^2(2J+1)Se^{-E_{JK}/kT}\times$$
$$\times\frac{\Delta\nu_{JK}}{(\nu_{JK}^2-\nu^2)^2+4\nu^2(\Delta\nu_{JK})^2}, \tag{10}$$

under the conditions $h\nu_{JK}\ll kT$, $hA\ll kT$ and $hB\ll kT$ (A and B being the rotational constants of the ammonia molecule), where N is the number of ammonia molecules per 1 cm^3, E_{JK} is the rotational energy and S is a multiplier, taking into account the nuclear statistical weight. Introducing in the calculations the intensities of spectral lines

$$I_{JK} = \frac{4\pi^2}{3ckT}\cdot\frac{N}{\Delta\nu_{JK}}\sqrt{\frac{B^2Ah^3}{\pi(kT)^3}}|\mu_{JK}|^2\nu_{JK}^3(2J+1)Se^{-E_{JK}/kT}, \tag{11}$$

we have

$$\alpha_{NH_3} = 4\nu^2\sum_{JK}I_{JK}\frac{\Delta\nu_{JK}^2}{(\nu_{JK}^2-\nu^2)^2+4\nu^2(\Delta\nu_{JK})^2}. \tag{12}$$

It is well known from experiment [25], that in pure ammonia and to pressures $P \approx 100$ mm Hg

$$\Delta\nu_{JK} \sim P \tag{13}$$

This threshold is increased in the mixture methane, hydrogen, ammonia, for $\sigma_{NH_3-H_2}, \sigma_{NH_3-CH_4} < \sigma_{NH_3-NH_3}$ (σ being the effective collision cross section). Since in the considered Jupiter model atmospheres pressure does not exceed 110 mm Hg, the correlation (13) is valid wherever the line half-width is determined by molecular collisions.

The best agreement with the experiment is also given by the temperature dependence [26]:

$$\Delta\nu_{JK} \sim \frac{1}{T}. \tag{14}$$

Unifying the correlations (13) and (14), we may write:

$$\Delta\nu_{JK} = \gamma_{JK}\frac{T_0}{T}P. \tag{15}$$

The measured half-widths of 15 lines NH_3 (concentration 100%) at room temperature T_K and $P = 1$ mm Hg. The half-widths of the remaining lines of ammonia under the same conditions may be computed by the Bleaney-Penrose formula [25]:

$$\Delta\nu_{JK}^{0}[Mc/s] = 30\left[\frac{K^2}{J(J+1)}\right]^{1/2}. \qquad (16)$$

For the mixture ammonia-hydrogen-methane, taking into account the above, we have

$$\Delta\nu_{JK} = \Delta\nu_{JK}^{0}\left(0.0012 + 0.9722\frac{\sigma_{H_2-NH_3}}{\sigma_{NH_3-NH_3}} + 0.0266\frac{\sigma_{CH_4-NH_3}}{\sigma_{NH_3-NH_3}}\right)P\frac{T_K}{T}. \qquad (17)$$

According to data of Table 55 [24] $\frac{\sigma_{H_2-NH_3}}{\sigma_{NH_3-NH_3}} \simeq 0.05$, and the ratio $\frac{\sigma_{CH_4-NH_3}}{\sigma_{NH_3-NH_3}}$ may be estimated, assuming, that by the strength of the analogous character of interaction $\sigma_{CH_4-NH_3} \simeq \sigma_{Ar-NH_3}$. Estimates give $\frac{\sigma_{CH_4-NH_3}}{\sigma_{NH_3-NH_3}} \simeq 0.07$. It must be noted that the inaccuracy of the last estimate of the ratio of effective cross sections because of low concentration of methane in Jupiter's atmosphere, leads to errors in the half-widths of the lines NH_3 not exceeding $\sim 3.5\%$.

The quantities γ_{JK} may be computed by using the correlations (15) and (17). Taking into account that the concentration of ammonia in the atmosphere of Jupiter constitutes 0.12%, and the correlations $N \sim P/T$ with (15) also, we find :

$$I_{JK} \sim \frac{0.0012T^{-2.5}e^{-E_{JK}/kT}}{0.0012 + 0.9722\frac{\sigma_{H_2-NH_3}}{\sigma_{NH_3-NH_3}} + 0.0266\frac{\sigma_{CH_4-NH_3}}{\sigma_{NH_3-NH_3}}}. \qquad (18)$$

The intensities of 65 lines of pure ammonia at room temperature are brought out in Table 46 of [24]. The resonance frequencies of ammonia's inversion spectrum ν_{JK} are given in the same table. We utilized in computations 51 lines only, their intensities being at the same time converted to conditions on the surface of Jupiter's clouds, in accordance with the correlation (18). The neglecting of the 14 weak lines of NH_3 during computations gives an error in τ not exceeding $\sim 1\%$ in the entire band considered.

We finally have for the absorption coefficient of ammonia :

$$\alpha(\nu, h_i) = 4\nu^2 \sum_{JK} I_{JK}(T_0)\left[\frac{T_0}{T(h_i)}\right]^{2.6} \exp\left[\frac{E_{JK}}{k}\left(\frac{1}{T_0} - \frac{1}{T(h_i)}\right)\right] \times$$
$$\times \frac{\left[\gamma_{JK}\frac{T_0}{T(h_i)}P(h_i)\right]^2}{(\nu_{JK}^2 - \nu^2)^2 + 4\nu^2\left[\gamma_{JK}\frac{T_0}{T(h_i)}P(h_i)\right]^2}. \qquad (19)$$

For the isothermic atmosphere we obtain from formula (4) :

$$\tau(\nu, h_i) = \frac{1}{2} H_0 \sum_{JK} I_{JK}(T_0) \ln\frac{(\nu_{JK}^2 - \nu^2)^2 + 4\nu^2 P_0^2 \gamma_{JK}^2 e^{-2h_i/H_0}}{(\nu_{JK}^2 - \nu^2)^2 + 4\nu^2(\Delta\nu_D)^2}. \qquad (20)$$

The integration in formula (4) was effected to the height h_m at which the half-width of the line becomes comparable with the Doppler $\Delta\nu_D$. Such a procedure is equivalent to cutting the atmosphere at a height $h_m \simeq 100 \div 200$ km (the values of h_m differ somewhat in different variants). Note that the contribution of higher atmosphere layers ($h_i > h_m$) to the quantity τ does not exceed 0.01 %. Only the narrow resonance regions constitute an exception. (See para 3).

For a nonisothermic atmosphere :

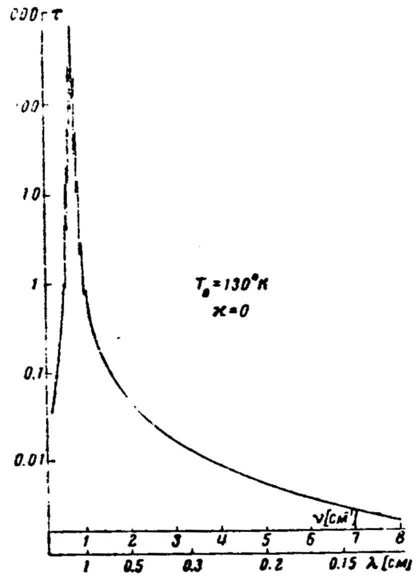
$$\tau(\nu, h_i) = \frac{4\nu^2}{\varkappa} \sum_{JK} I_{JK}(T_0) \int_{T(h_i)}^{T_c} (T_0/T)^{2.5} \exp\left[\frac{E_{JK}}{k}\left(\frac{1}{T_0} - \frac{1}{T}\right)\right] \times$$
$$\times \frac{[\gamma_{JK}P_0(T/T_0)^{-(1+(mg/k\varkappa))}]^2}{(\nu_{JK}^2 - \nu^2)^2 + 4\nu^2[\gamma_{JK}P_0(T/T_0)^{-(1+(mg/k\varkappa))}]^2}\, dT + \tau_c, \qquad (21)$$

where

$$\tau_c = \frac{H_c}{2} \sum_{JK} I_{JK}(T_0)\,(T_0/T_c)^{2.5} \ln\frac{(\nu_{JK}^2 - \nu^2)^2 + 4\nu^2\gamma_{JK}^2 (T_0/T_c)^2 P_c^2}{(\nu_{JK}^2 - \nu^2)^2 + 4\nu^2(\Delta\nu_D)^2} \times$$
$$\times \exp\left[\frac{E_{JK}}{k}\left(\frac{1}{T_0} - \frac{1}{T_c}\right)\right]. \qquad (22)$$

The calculation of atmosphere opacity (nontransparence) and brightness temperature was conducted by means of a BESM - P computer.

3. - <u>Results of Calculation</u>.- The results of calculation of the optical thickness of an isothermic atmosphere according to formula (20) and for $h_i = 0$ are plotted in Figures 1 and 2 [next page].



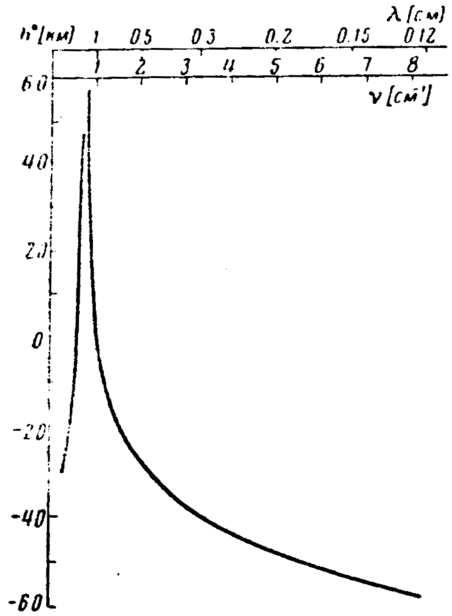


Fig. 1. Optical thickness τ of the isothermic atmosphere of Jupiter in the region $\lambda \simeq 1.3$ mm ÷ 3 cm

Fig. 3. - Levels of radiation egress h* in an isothermic atmosphere of Jupiter as a function of wavelength.

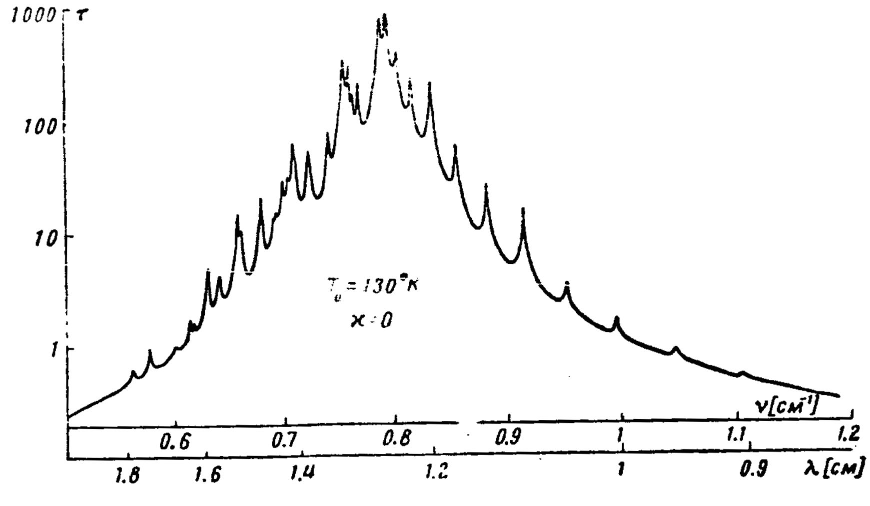


Fig. 2. - Optical thickness of the isothermic atmosphere of Jupiter in the region $\lambda \simeq 1.3$ mm ÷ 3 cm

The spacing for the calculations was chosen equal to $0.1\ cm^{-1}$ in the regions $\nu = 0.3\ cm^{-1} \div 0.45\ cm^{-1}$ $1.3\ cm^{-1} \div 8\ cm^{-1}$ and to $0.001\ cm^{-1}$ in the region $0.45 \div 1.3\ cm^{-1}$. It may be seen from the figures 1 and 2 that radiation in the region $\lambda \simeq 1\ cm \div 1.65\ cm$, apparently emerges from the above-cloud part of the atmosphere. (Under the level of egress it is understood, as usual, that $h_1 = h^*$ for which $\tau(h^*) = 1$).

Plotted in Fig. 3 are the calculated levels of radiation emergence as a function of wavelength. The computations of the quantity h^* were made by the formula

$$h^*(\nu) = \frac{H}{2} \ln \tau(\nu, 0), \tag{23}$$

which follows from (20) under the conditions :

$$(\nu_{JK}^2 - \nu^2)^2 \gg 4\nu^2 (\Delta\nu_{JK})^2, \quad \Delta\nu_{JK}^2 \gg \Delta\nu_D^2. \tag{24}$$

The conditions (24) are fulfilled in the frequencies $\nu \leqslant 0.5\ cm^{-1}$ and $\geqslant 1.2\ cm^{-1}$ In the region $\nu \simeq 0.5\ cm^{-1} \div 1.2\ cm^{-1}$ the values of $h^*(\nu)$ were found from an earlier obtained dependence $\tau(h_1)$ through formula (20).

It should be noted that the curve of Fig. 3 is smoothed out in the region of altitudes $h^* > 0$. The smoothing was determined by the spacing of calculations of (h_1) by frequency, which was equal to $0.08\ cm^{-1}$ (it is difficult to judge on the degree of smoothing from Fig. 2). The curve in Fig. 3 was not computed by us in the region $\nu \simeq 0.7 \div 0.8\ cm^{-1}$, because the computation of emergence levels in that region would entail a significant error (to 100%) because of atmosphere cutdown at finding the optical thickness (see para 2), as the atmosphere layers, lying above h_m, provide in these frequencies a notable contribution to absorption. Computations indicate that the emergence levels in a nonisothermic atmosphere differ from the corresponding ones in an isothermic atmosphere by no more than $\simeq 4$ km. Since the determination itself of radiation emergence levels is to a known degree conditional, the indicated discrepancy is insignificant and the calculation of the values of $h^*(\nu)$ for an isothermic atmosphere may be a source of information in the first approximation.

Plotted in Figures 4 – 6 are the brightness temperatures of Jupiter for different atmosphere models. The claculation of the values of T_B is made with a frequency spacing of $0.05\ cm^{-1}$. This conditions the smoothness of the curves drawn in the said figures. Note that the error connected with this (ΔT_B) over a plane portion $T_B \simeq T_c$ does not exceed 10 percent in the case $\varkappa = -2.01^\circ$ K/ km and $\simeq$ 6 percent for $\varkappa = \pm 1^\circ$ K / km.

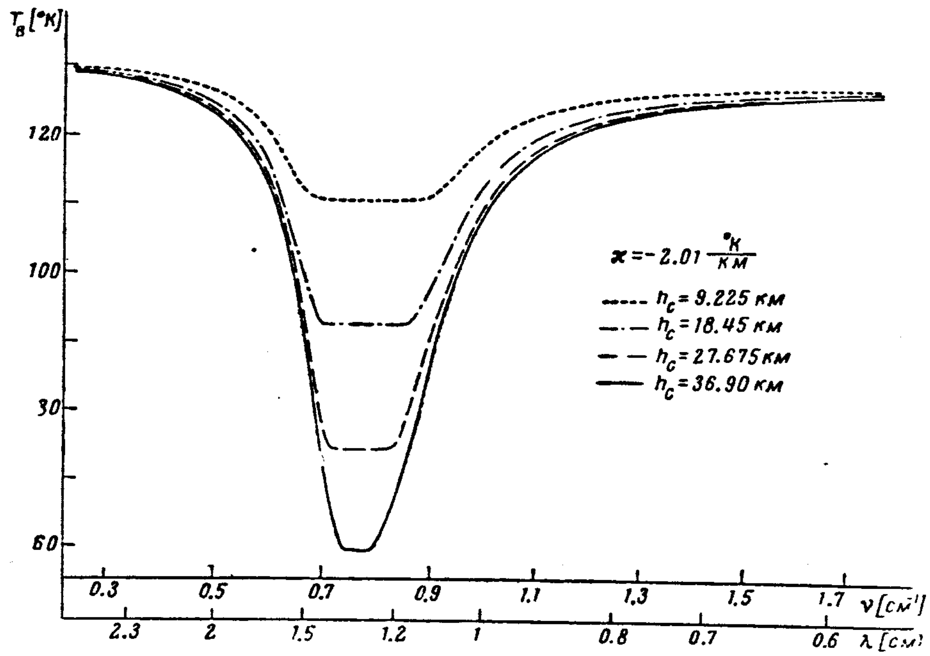


Fig. 4. - Brightness temperature T_B of Jupiter in the range $\lambda \simeq 5$ mm $\div$ 3 cm for a series of isothermic models of the atmosphere

The respective error on the slopes of the curves of Figs. 4 — 6 does not exceed $\simeq$ 5 — 6 percent *. Because of the absence of integration over the disk in formula (7) the maximum error in the value of T_B is tolerated, as may be seen from formula (7), in the region $\tau \sim 1$, that is in the regions $\nu \simeq 0.55 \div 0.63$ cm^{-1} and $\nu \simeq 0.96 \div 1.1$ cm^{-1}. But even in these regions the error does not exceed 2.5 percent. In the region $T_B \simeq T_c$ this error constitutes only fractions of percent. In the regions $\nu < 0.55$ cm^{-1} and $\nu > 1.1$ cm^{-1} it is just as small.

It may be seen from Figs. 4 — 6 that the most interesting region for the experimental investigation is $\lambda \simeq 1.05$ cm $\div$ 1.54 cm , for in it one may expect a notable departure in the brightness temperature of Jupiter from the value 130° K for certain model atmospheres of the planet.

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* For the estimate of the given error on separate portions of the spectrum, calculation of the value of T_B was made with a tinier spacing by frequency.

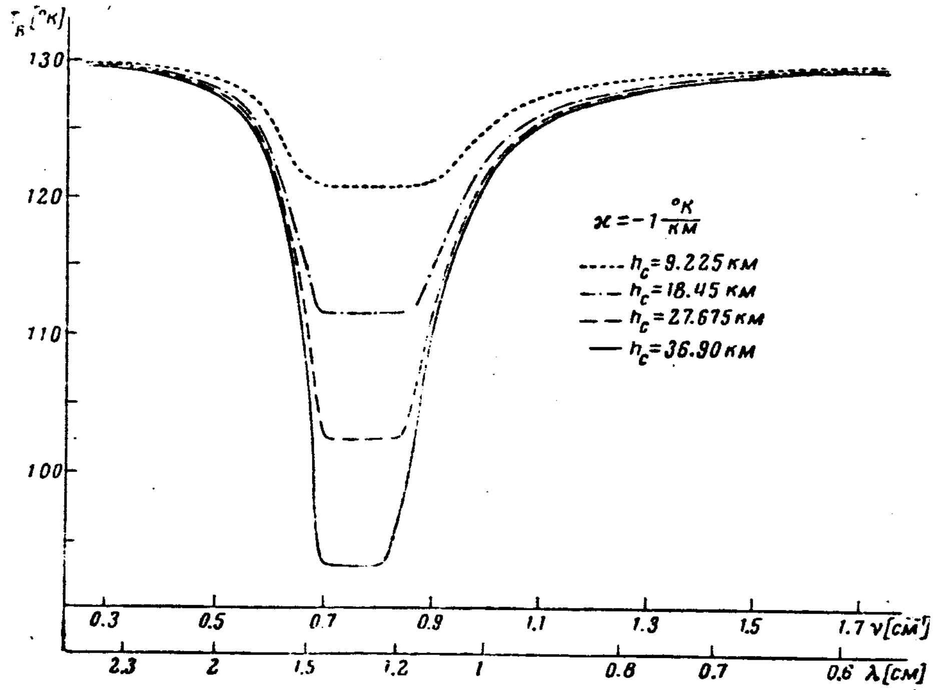

Fig. 5

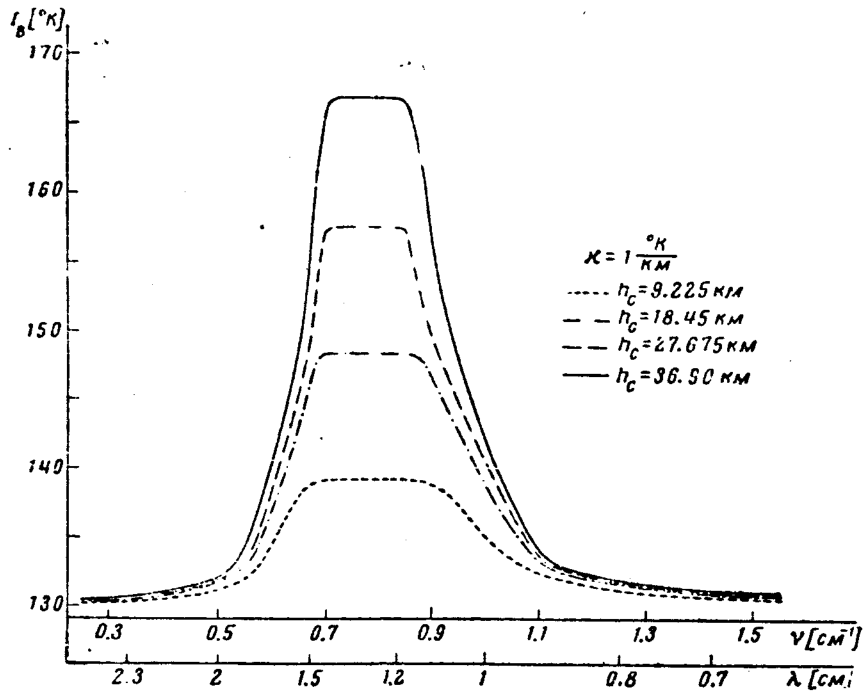

Fig. 6

Figures 5 and 6 have identical captions to that of Fig. 4

Thus, for example, for $h_c = 36.90$ km and $\varkappa = \pm 1^\circ$ K/km at the center of the indicated region we shall have $|130^\circ K - T_B| \simeq 37^\circ$ K, and for $\varkappa = -2.01^\circ$ K/km we shall have $|130^\circ K - T_B| \simeq 70^\circ K$.* At boundaries of the region $\lambda \simeq 1.05$ cm $\div$ 1.54 cm, the corresponding discrepancy by module will constitute 15° K, 30° K, 12° K, 25° K. At the same time it is necessary to note, that for $h_c = 9{,}225$ km the difference in the brightness temperature from 130° K does not exceed $\simeq 13^\circ$ K for all values of $\varkappa$. Note that the measurement of the emission spectrum of Jupiter in the region $\lambda \simeq 1{,}25$ cm at sea level is beset with difficulties occurring on account for strong absorption by water vapor in the Earth's atmosphere [27]. However, the latter drops rapidly with height, which alleviates the setup of the corresponding experiment.

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***** THE END *****

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N. B. NOTE AT CORRECTION OF THE PAPER

By that time works [28, 29], referring to some questions of atmosphere structure of Jupiter, were published, with emphasis on the brightness temperature in the region $\lambda < 3$ cm. In [28], it was experimentally found that $T_B = 144 \pm 23^\circ$ K for $\simeq 8.35$ mm. The indicated value of T_B agrees well not only with the Kuiper model [14], as taken into account by authors of [28], but also with the model atmospheres considered in the paper. The estimates of the temperature gradient in the above-cloud layer of Jupiter in [29] gave the value $\varkappa = 4.3^\circ$ K/km, close to that for the Kuiper model. The overrated hydrogen content in Kuiper models [14] was already noted above. The estimates of the value of T_B for other gradients $\varkappa$ and heights h_c can be easily made by using the material expounded. And finally, the effect of possible inhomogeneity of the chemical compositionnof Jupiter's atmosphere, linked with the freeze out of ammonia, upon T_B may be qualitatively represented from the data obtained for Saturn.

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* [insert]. For $h_c = 18.45$ km and $\varkappa = 1^\circ$ K/km, we have at the center $|130^\circ K - T_B \simeq 18$ K, and for $\varkappa = -2.01^\circ$ K/km, $|130^\circ K - T_B \simeq 37$ K.

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